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A further note on *Archachatina churchilliana* and a description of the genital anatomy of *Archachatina natalensis* (Mollusca: Pulmonata: Achatinidae)

by

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ABSTRACT

A previously unknown character state of the highly polymorphic shell of *Archachatina churchilliana* (Melvill & Ponsonby, 1895) is recorded, possibly indicating that all uniform yellow shells of this species, hitherto discussed, are not fully grown. The previously unknown genital anatomy of *Achatina natalensis* Pfeiffer, 1854, is described, indicating that it should be transferred to a different genus and subgenus.

INTRODUCTION

Two uniformly pale yellow species of the family Achatinidae, namely *Archachatina churchilliana* (Melvill & Ponsonby, 1895) and *Achatina natalensis* Pfeiffer, 1854, have been described from the province of KwaZulu-Natal, South Africa. [As will be indicated below, the latter species clearly does not belong to the genus *Achatina* and it will thus henceforth, according to the system of Mead (1991), be referred to as *Archachatina (Tholachatina) natalensis* (Pfeiffer, 1854).] Both above mentioned species were originally described as having pale yellow shells. This differs from the majority of Achatinidae in which the shell normally bears chestnut-brown to black axial flammules, with only occasional individuals within a species having uniformly yellow shells. A study (Sirgel 2000) of the shells and genital anatomy of *A. churchilliana*, as well as the flammulate *Archachatina zuluensis* (Connolly, 1939) and *Archachatina sanctaeluciae* Bruggen, 1989, led to the suggestion that these three were in fact mere variations of one polymorphic species, for which the name *Archachatina (Tholachatina) churchilliana* (Melvill & Ponsonby, 1895) should take precedence. This suggestion was confirmed (Sirgel 2002) when an individual with a uniformly pale yellow shell was bred from two generations of flammulate *A. sanctaeluciae*. At the age of one year, with 7.5 whorls, this individual conchologically conformed to the description of *A. churchilliana* in having the following measurements: length 68.5 mm; diameter 30.2 mm; length/diameter ratio 2.27; length of last whorl 40.5 mm; total length/length of last whorl ratio 1.69.

Amongst the small number of shells belonging to the flammulate *sanctaeluciae* morph of this species in the author's collection, a few range from 80–94 mm in shell length and consist of nine or more whorls. These shells thus tend to be relatively more slender and distinctly longer than the uniformly yellow ones so far recorded for *A. churchilliana*. The latter were recorded as having 7–8 whorls and a length ranging from 57–74 mm, with the 74 mm long holotype being the only specimen longer than 70 mm (Sirgel 2000, 2002). This may create the impression that the trait for a uniform yellow shell is linked to one for a smaller and shorter shell in this species. As has been shown (Sirgel 2002) for *A. churchilliana*, shell polymorphism may be a highly confusing phenomenon in achatinid systematics. To aid in a more accurate diagnosis, further information on the variation of the shell is supplied here.

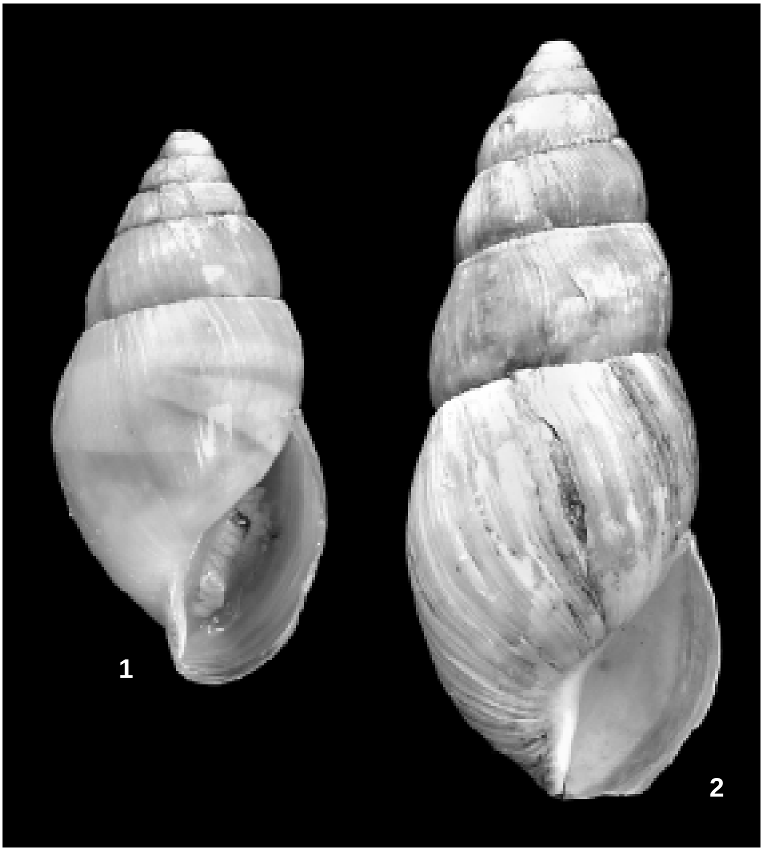
Connolly (1939) recorded three shells of *Archachatina natalensis* (Pfeiffer, 1854) from South Africa as the only authentic examples known to him, and cited the type locality as ‘Port Natal’ [= Durban]. As a second locality he added ‘Lorenzo Marques’ [= Maputo] in southern Mozambique, but warned that the correctness of these localities was open to question. As no further specimens of this species had been collected from the type locality or for that matter from the entire province of KwaZulu-Natal, both Bequaert (1950) and Bruggen (1965) believed that it was not a South African species. Bequaert (1950) in fact regarded it as most closely related to *A. welwitschi* Morelet, 1866, from Angola and suggested that both species belonged to the subgenus *Achatina sensu stricto*. He further suggested that if *A. natalensis* was a West African species it should be rediscovered somewhere in lower Guinea, which he defined as the region from Cameroon to the Orange River. However, R.W. Plant, source of all the specimens known to Connolly, is known to have collected only between Durban and Maputo in Mozambique and inland to about 150 km north of Pietermaritzburg (Gunn & Codd 1981; R. Kilburn, *pers. comm*).

Recently a live specimen of *A. natalensis* was collected on Inhaca Island off Maputo, which is less than 100 km to the north of the KwaZulu-Natal border. This confirms Plant’s locality record of ‘Lorenzo Marques’ and demonstrates that this is not a West African species after all.

This specimen enables details of the previously unknown anatomy of *A. natalensis* to be investigated. Mead (1950, 1979) and Bruggen (1972) emphasized that a meaningful evaluation of the relationships and phylogeny of Achatinidae could only be reached by taking into account both the characters of the shell and the anatomy of the genital system. The genital anatomy of this specimen is here described in order to enable future researchers to identify this species with more confidence. Such information, which is still lacking for many of the South African Achatinidae, is very important for the correct interpretation of the systematics of this family.

Archachatina churchilliana (Melvill & Ponsonby, 1895)

Observations: The above-mentioned individual of *Archachatina churchilliana* with a uniformly pale yellow shell, bred from flammulate parents and grandparents, attained 7.5 whorls and a length of 68.5 mm at the age of one year (Fig. 1). Other similar-sized pale yellow specimens, on dissection, presented a fully developed genital system (Sirgel 2000) and it seemed logical to assume that this captive-bred individual was more or less fully grown at that time, as no other specimens of this morph with a significantly larger shell have been recorded. The specimen was nonetheless kept in the laboratory for a further two years (to February 2004) at which stage it died. During its second year of life it added another 1.5 whorls to the shell, to reach nine whorls with a total length of 93.5 mm and a diameter of 36 mm, with the last whorl measuring 56 mm. The result of this added growth was a shell with a size and shape (Fig. 2) significantly different from that in the original description of *A. churchilliana*. Shell size at one year (Fig. 3) is more or less equal to that given for *A. natalensis* by Connolly (1939), and they will be compared towards the end of this paper.

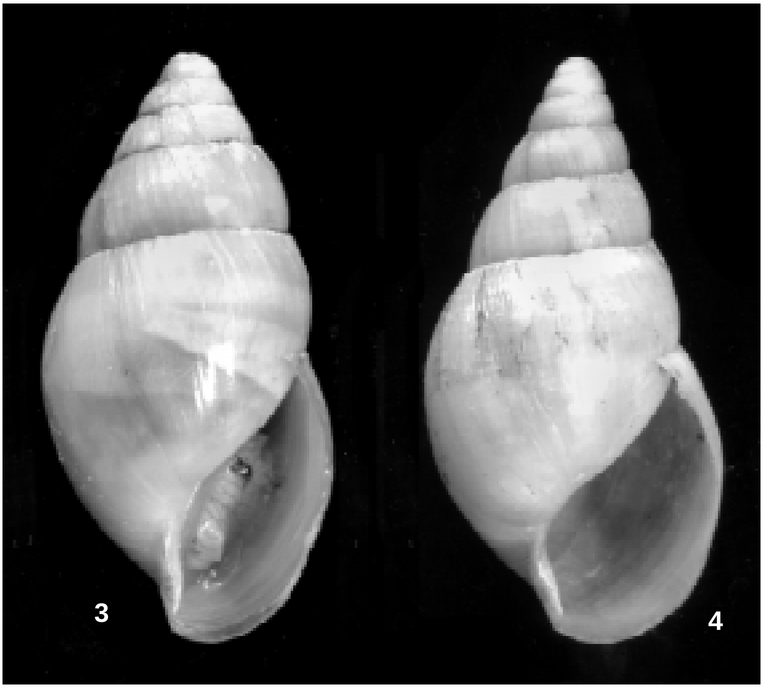


Figs 1, 2. *Archachatina churchilliana*. The same specimen at the age of one year (Fig. 1, length 68.5 mm) and three years (Fig. 2, length 93.5 mm).

Remarks: It is thus clear that, at least under controlled conditions, individuals of *A. churchilliana* with pale yellow shells are capable of growing to the same size as the flammulate ones. This poses the question as to why such apparently fully grown specimens have never been collected in the field, considering that absence of flammulation is clearly not a trait linked to smaller size. There may be a number of explanations, but one possibility could be that the non-flammulate shells are less camouflaged in their natural habitat than their flammulate counterparts and are thus taken by predators before they become fully grown.

Archachatina natalensis (Pfeiffer, 1854)

Observations: The above mentioned specimen of *Archachatina natalensis* (Natal Museum accession no. L5564) was collected by Miss Pam Cairns on Inhaca Island (26º05'S 32º55'E), Mozambique, on 25 March 2001. It was kept alive in the Natal Museum for a year and then preserved in April 2002 (Mrs Linda Davis *pers. comm.*). This specimen was kindly made available to me for examination. The shell (Fig. 4) corresponds very well with the type specimen illustrated by Connolly (1939) and has



Figs 3, 4. Comparison of similarly sized shells of *Archachatina natalensis* and *A. churchilliana*. Fig. 3, one-year old *A. churchilliana*. Fig. 4, *A. natalensis*, length 60.5 mm.

the following morphometrics; whorls 7.5+; length 60.5 mm; diameter 30.5 mm; last whorl 41.5 mm; length/diameter ratio 1.98; total length/length of last whorl ratio 1.46. During dissection, eleven eggs were found in the free oviduct and spermoviduct, proving that the individual had reached sexual maturity. Four of these eggs were removed to make it possible to draw a clear figure of the relationships between the various parts of the genital system.

Genital anatomy: Numerical data on genital structures are given in Table 1. Penis extends above thin-walled penis sheath (Fig. 5), slightly shorter than vagina; tripartite consisting

TABLE 1

Measurements of genital system of *A. natalensis* (mm).

Penis length	10.2
Basal part of penis diam.	1.2
Penis sheath length	8.2
Free oviduct length	19.0
Basal vas deferens length	7.5
Basal vas deferens diam.	0.5
Apical vas deferens length	28.4
Apical vas deferens diam.	1.2
Vagina length	13.7
Spermathecal duct length	18.3
Spermathecal duct diam.	1.0
Spermatheca length	4.5
Spermatheca diam.	2.3

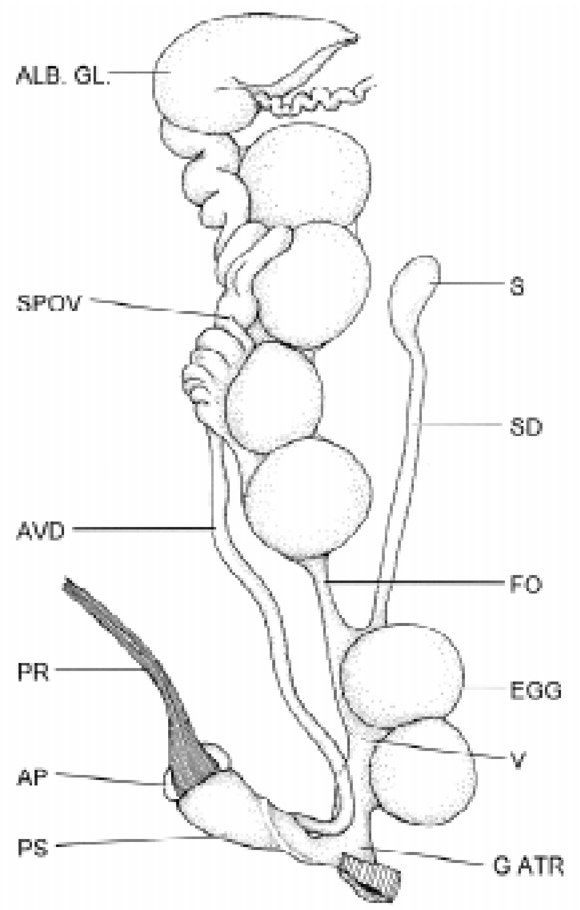


Fig. 5. *Archachatina natalensis*, genital system spread out, showing six of the eleven eggs found in the female ducts of the dissected specimen. Ventral view: ALB GL - albumen gland; AP - apical part of penis; AVD - apical vas deferens; FO - free oviduct; G ATR - genital atrium; PR - retractor muscle of penis; PS - penis sheath; S - spermatheca; SD - spermathecal duct; SPOV - spermoviduct; V - vagina.

of a tubular basal part (length 4.2 mm, diameter 1.2 mm) followed by a subapical part (length 4 mm) which gradually expands in diameter as it extends apically to reach a diameter of about four times that of the basal part; the third or apical part extending above penis sheath is bean-shaped (4.5 x 2 mm), its longitudinal axis orientated transversely in relation to the two more basal parts (Fig. 6); wall of basal part of penis relatively thin, that of subapical part about twice as thick while that of the apical part is even thicker; internal surface of penial wall not thrown into longitudinal rugae, but thin threadlike fibres, arranged in a net-like pattern, can be perceived in this almost smooth inner surface of the penial wall; basal vas deferens emerges from the ventral side of the apical part of the penis (Fig. 6) and extends in a basal direction along the penis to pass through the penis sheath close to its basal end (Fig. 6); it is not embraced by a fold of the penial wall on its course. Muscle fibres originate from a thin strip running along the length of the inner surface of the penis sheath. These fibres continue along the length of

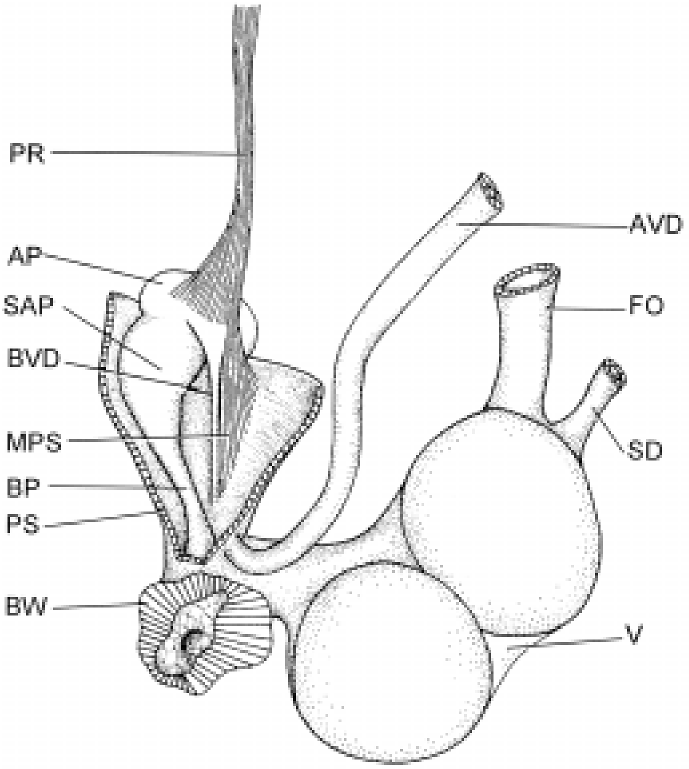


Fig. 6. *Archachatina natalensis*, basal part of genital system with penis sheath slit open. AP - apical part of penis; AVD - apical vas deferens; BP - basal part of penis: BVD - basal vas deferens; BW - body wall surrounding genital aperture; FO - free oviduct; MPS - muscle fibres connecting basal vas deferens to penis sheath; PR - retractor muscle of penis; PS - penis sheath; SAP - subapical part of penis; SD - spermathecal duct; V - vagina.

the basal vas deferens towards the apex of the penis, forming a thin muscular curtain connecting the penis sheath to the vas deferens, but not to the penis itself in the specimen dissected (Fig. 6). On reaching the apex of the penis these fibres merge with others originating from the central region of the apical part of the penis to form the penial retractor muscle. This muscle traverses the sagittal myoseptum to join the columellar muscle band of the right side some distance apically of the septum. It should however, be kept in mind that the point of insertion of this muscle is very variable amongst individual members of Achatinidae (Mead 1995*a*). Apical vas deferens emerges from the penis sheath close to the peniovaginal angle, with distinctly larger diameter than basal vas deferens, continued along vagina and free oviduct; spermathecal duct long; carries a clavate spermatheca which is attached to the spermoviduct apical to the junction of the apical vas deferens and free oviduct. Each of the eleven eggs found in the system measured 8.9 x 7.5 mm.

Remarks: The general pattern of the genital system of *Archachatina natalensis* (Fig. 5) conforms to that described by Mead (1988, 1991, 1995*a*) for the South African members of the genus *Archachatina*, subgenus *Tholachatina*. He points out that the subgenus

Achatina s.s. of *Achatina* differs by typically having a short spermathecal duct with a relatively large sacculate spermatheca attached to the free oviduct, thus not reaching the junction of the vas deferens and free oviduct. The presence of a penial atrium also elevates the emergence of the apical vas deferens from the penial sheath well above the common genital atrium in the subgenus *Achatina*. These characters are absent in *A. natalensis*. Neither does *A. natalensis* have a muscular bulboid enlargement of the basal vagina nor an elevated emergence of the apical vas deferens, as described for *Achatina (Lissachatina)* by Mead (1991).

These characters indicate that *A. natalensis* belongs to the southern African section of the genus and subgenus *Archachatina (Tholachatina), sensu* Mead (1991). But subsequently Mead (1995*b*) suggested that the subgenus name *Tholachatina* should be reserved for a group now largely restricted to the Lake Region of central eastern Africa. He believes that the 'Southern African branch' originated from the 'East African branch' of Achatinidae, and gave origin to a genus, for which he suggests that the name *Cochlitoma* Férussac, 1821 should be resurrected. Should these suggestions of Mead (1995*b*) be accepted, the southern Africa species previously referred to the genus and subgenus *Archachatina (Tholachatina),* will have to be re-allocated to the genus *Cochlitoma.*

The genital system of *A. natalensis* deviates in a few minor respects from that normally found in those few members of the so-called Southern African *Archachatina (Tholachatina)* group (*Cochlitoma, sensu* Mead 1995*b*) for which the genital anatomy is known. The penis for instance resembles that described for *Archachatina (Tholachatina) livingstonei* (Sirgel 2000) in extending above the penis sheath, but differs from the condition described for all other species in this group. The emergence of the basal vas deferens from the ventral side of the apical part of the penis, instead of from its base, seems to be a unique character, found within this group only in *A. natalensis*. Furthermore, the basal vas deferens, not being embraced in a longitudinal fold of the penial wall along its course, differs from the condition usually found in this group (Mead 1991). *A. livingstonei*, however, shows only slight signs of such a condition, in having a short and very shallow concavity in a corresponding position (Sirgel 2000). This seems to suggest that both *A. natalensis* and *A. livingstonei* present a primitive condition in this respect.

CONCLUSION

Connolly (1939) associated both *A. natalensis* and *A. churchilliana* in the same subgroup *natalensis*, and believed them to be closely allied. His decision was obviously based on shell characters as he defined this group as typically having 'unicoloured yellow shells'. However, he did allow for the possibility of flammulation in declaring that fuller acquaintance might establish a relationship between them and 'flammate' species.

Structurally, similar-sized shells of these two species (Figs 3, 4) differ in the following respects. In *A. natalensis* the moderately convex whorls increase regularly in diameter while the suture separating each from its predecessor is located close to the periphery of the preceding whorl. This results in the spire having a straight profile. By contrast, in *A. churchilliana* the suture of each whorl is located more towards the base of its predecessor, causing the spire to be slightly more produced and each whorl to be less convex. This results in the profile of the spire being convex (cyrtoconoid) (Fig. 3), rather than straight (orthoconoid) as in *A. natalensis* (Fig. 4). The columella in the latter species is also more concave.

As far as genital anatomy is concerned, *A. natalensis*, apart from the above-mentioned specific differences from other species in the group, clearly differs from *A. churchilliana* in that the penis lacks the large ear-like transverse extension described for the latter (Sirgel 2000). The full significance of this difference however, will only become clear once the genital anatomy of most of the South African Achatinidae has been described.

Finally, shell shape in *A. natalensis* closely resembles that of *Archachatina semigranosa* (Pfeiffer, 1861) in which uniformly yellow shells can occur. However, surface granulations are much more pronounced in the shell of *A. semigranosa*.

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